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ABSTRACT

A technique was developed utilizing socioeconomic and school-related variables for allocating state funds to elementary and secondary schools on the basis of specified state priorities. Principal component analysis was used to reduce variables to a set of factors reflecting the independent dimensions of socioeconomic, resource utilization, and programmatic groups. Factor scores were then calculated for each group and used in regression equations for eight trial application models. The technique facilities recognition of inschool and out-of-school variables, promotion of efficiency among school districts, and incorporation of policy interests into the state school support allocation system. (Author)

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A MULTI-FACTOR INDEX TECHNIQUE FOR STATE EDUCATION FUNDING

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A MULTI-FACTOR INDEX TECHNIQUE FOR STATE EDUCATION FUNDING

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Introduction

Currently-used methods of allocating state funds for the operation of public schools were based on the work of school finance theorists in the early part of this century. At that time the goal was to standardize at some level a statewide uniform minimum educational program funding level while permitting those school boards able to and interested in providing additional services to do so. Although American educational, social, technological, and industrial patterns have become much more complex than they were in the 1920s, methods of allocating funds for public education have not greatly changed, and the typical state funding program today is a patchwork of foundation, categorical, and supplemental allocations. Also, growing demand for public services and the concommitant requirement for greater fiscal accountability dictate a search for a more systematic approach to providing funds for education. In view of recent advances in data handling and analysis techniques, consideration must be given to the design, field testing, and implementation of comprehensive state school support mechanisms that recognize the wide variations in educational need existing among school districts.

Purpose

The purpose of this study was to develop a systematic state school support allocation technique capable of recognizing a variety of district socioeconomic and school-related characteristics and allocating funds on the basis of specified state priorities.

Scope of Study and Source of Data

The scope of the study was limited to consideration of data available for all of the sixty-seven county-based school districts of Florida for the 1973-74 fiscal year. Federal census data for 1970 were used for analysis. State figures on referrals to juvenile courts were obtained from the Florida Department of Health and Rehabilitative Services. Educational data were obtained from the Florida Department of Education.

Detailed programmatic data were not available for the 1972-73 school year; therefore, full-time equivalent pupil (FTE) and weighted full-time equivalent pupil (WFTE) data for 1973-74 were accepted as proxies for programs in the earlier year. Funding categories for special and vocational education FTE and WFTE data were each summed to obtain aggregate program figures. Achievement data, including standardized test scores from the statewide testing program for Grades 3, 6, and 9, were also included in the subgroup as measures of student need for additional programs. Other variables such as percent of nonpromotions in Grades K-12, dropouts in Grades 10-12 as a percent of graduates not immediately continuing their education in vocational or academic institutions were included as possible indexes of need for programs within a school system.

Method

To develop funding models capable of reflecting a variety of socio-economic, resource utilization, and programmatic characteristics of a school district, a four-phase research design was implemented. In the first phase variables related to these areas of interest were selected for consideration and placed in the appropriate grouping. The variables were subjected to

principal component analysis to isolate the factors with the most explanatory power in each subgroup in phase two. Factor scores for these factors were calculated in phase three, and these were grouped to produce model funding programs. Phase four dealt with the analysis of the impact of the developed models on funding patterns for local school districts in Florida.

Phase 1: Data Gathering. In the development of the state funding technique, the intention was to select variables related to research in the area of educational productivity and to utilize data available through standard reporting procedures. The replicability of model development was also considered important; therefore, variables were desired that would enable replication and comparison with future applications of the developed technique in other states.

In addition to the guidelines described above, several other considerations entered into the selection of variables. First, variables were selected, based on related research, in terms of their potential capacity to discriminate between school districts on socioeconomic, resource utilization, and programmatic characteristics. Second, data were collected for the 1972-73 school year whenever possible. Third, because of the wide differences in size of school districts in Florida, variables were expressed in percentage form whenever possible to eliminate the overwhelming effect of size in comparing data among districts.

An an initial step in data analysis, the mean, standard deviation, kurtosis, skew, range, and minimum and maximum scores were calculated for each variable using the subprogram CONDESCRIPTIVE of the Statistical Package for the Social Sciences (SPSS). These statistics were then used to check the data and to gain further insights into the type of data being used

in the study. For example, by examining the range and minimum and maximum scores, it was possible to detect keypunch errors and format errors. Information on the skew and kurtosis of each variable revealed that the variables were normally distributed in only a very limited number of instances, allowing correcting transformations to be made where needed.

Phase 2: Development of Factors. In the second phase of the study principal component analysis was applied to the variables of the socioeconomic, resource utilization, and programmatic subgroups to extract sets of variables, or factors, that were uncorrelated. These factors were then analyzed for use in the allocation models. The SPSS subprogram FACTOR was used for this analysis, and PA1, principal factoring with iteration, was specified as the initial factor solution with VARIMAX rotation.

By means of repeated principal component analyses, the large number of variables available for inclusion in each subgroup was decreased to a number of variables that provided maximum explanation of variance with the minimum number of variables. Moreover, variables that were highly intercorrelated or variables that would not be politically practicable for inclusion in a state funding program--such as the percent of illegitimate births--were dropped from further consideration.

Through prinicpal component analysis the forty-eight socioeconomic variables were reduced to three factors with eigenvalues greater than one explaining 72.4 percent of the variance in the data. Table 1 contains the varimax rotated factor matrix for the three socioeconomic factors, the variable names, the variable loadings on each factor, and the percentage of variance explained by each factor. The factors for the socioeconomic data were named S1, S2, and S3 in the order of their statistical importance.

In this set of factors some variables reflect demographic conditions or characteristics and others are indicative of social behavior. Variables

TABLE 1

SOCIOECONOMIC FACTORS

Variable Number	Variable Name	Factor Loadings Factor S1	Factor S2	Factor S3
TRN039	Median Years of School Completed	0.90002	-0.00233	-0.10154
TRN010	Population per Square Mile	-0.79418	0.04792	-0.00165
TRN181	Percent Change in Population 1960-70	0.70936	0.28237	-0.16931
TRN018	Juvenile Referrals as Percent Population Ages 5-17	-0.62513	0.06394	-0.56142
TRN045	Arrest Rate per 1,000 Population	-0.13900	0.84018	-0.03502
TRN013	Percent Nonwhite Population	0.26587	0.80028	0.18320
TRN041	Percent Unemployed	-0.23193	0.13181	0.86468
Percent of Variance Explained		35.9	21.2	15.3

that were primarily economic measures did not correlate highly enough with any factor to be included. Note that although the juvenile delinquency variable loaded heavily with the density-population mobility-education factor P1 (see Table 3) and with the unemployment focus of Factor S3, the juvenile delinquency-unemployement measure appeared to be unrelated to the minority population-high crime rate characteristics measured by Factor S2.

Three factors were also identified for the resource utilization variables. In combination, these three factors, shown in Table 2, explained 60.3 percent of the variance in the data. Two factors, pupil-instructional personnel ratio and the percent of experienced teachers, contributed to more than one factor. Variables related to teacher training and experience had the highest level of importance in this subgroup of variables.

Two programmatic factors were defined, explaining 67.7 percent of the variance in the data set. These factors and their loadings are listed in Table 3. Variables related to school completion and the continuation of education were found in both factors. The factor containing the achievement variable, P1, was a strong factor in terms of the high correlations that all variables present had with it.

Table 4 lists the primary variables in each of the eight factors developed.

Phase 3: Development of Funding Models. After factor loadings were obtained for each subset of variables, factor scores for each factor were calculated. The SPSS subprogram FACTOR calculated exact factor scores for each of the eight factors developed. Table 5 gives the range of scores found for each factor. Factors S1 and S2 are less well-balanced than the six factors, indicating that the diversity of conditions was not as great among the districts for the characteristics measured by these factors.

TABLE 2

RESOURCE UTILIZATION FACTORS

Variable Number	Variable Name	Factor Loadings Factor R1	Factor R2	Factor R3
TRN207	Percent Teachers with Ed.D./Ph.D. Degrees	0.76687	0.16315	0.22841
VAR204	Percent Teachers with B.A. Degrees	-0.72234	0.27239	0.17266
TRN207	Percent Teachers with Continuing Contracts and Seven or More Years of Experience	0.50412	0.09860	-0.67895
VAR205	Percent Teachers with Annual Contracts	0.17418	0.71620	0.34948
TRN025	Teaching Materials as a Percent of Total Current Expenditures	0.15278	-0.67438	0.07682
TRN027	Pupil-Instructional Personnel Ratio	-0.01596	-0.58011	0.51280
TRN024	Health Expenditures as a Percent of Total Current Expenditures	0.14210	0.09356	0.65709
Percent of Variance Explained		22.1	20.2	18.0

TABLE 3

PROGRAMMATIC FACTORS

Variable Number	Variable Name	Factor Loadings Factor P1	Factor P2
TRN036	Percent Graduates Not Immediately Continuing Their Education in a Vocational or Academic Institution	0.85789	0.19922
TRN183	Twelfth Grade Aptitude Raw Score	-0.78657	0.13996
VAR210	Average Daily Membership as a Percent of Weighted Full-time Equivalent Pupils	0.38012	0.76208
TRN031	Percent Change in Membership from First Month to Ninth Month, Grades 10-12	-0.40050	0.67360
Percent of Variance Explained		40.7	27.0

TABLE 4

PRIMARY VARIABLES OF THE EIGHT FACTORS

Factor	Variables Included
S1	Population Per Square Mile Referrals to Juvenile Courts as a Percent of Total Population Ages 5-17 Percent Change in Population 1960-70 Median Years of School Completed
S2	Nonwhite Population as a Percent of Total Population Arrest Rate Per 1,000 Population
S3	Referrals to Juvenile Courts as a Percent of Total Population Ages 5-17 Percent Unemployment
R1	Teachers with Doctorate Degrees as a Percent of Total Teachers Teachers with B.A. Degrees as a Percent of Total Teachers Teachers with Continuing Contracts and Seven or More Years of Experience as a Percent of Total Teachers
R2	Teachers with Annual Contracts as a Percent of Total Teachers Expenditures for Teaching Materials as a Percent of Total Current Expenditures Pupil-Instructional Personnel Ratio
R3	Teachers with Continuing Contracts and Seven or More Years of Experience as a Percent of Total Teachers Health Expenditures as a Percent of Total Current Expenditures Pupil-Instructional Personnel Ratio
P1	Percent Graduates Not Immediately Continuing Their Education in an Occupational Training or Academic Institution Average District Aptitude Raw Score for Twelfth-Graders on the Statewide Testing Program

TABLE 4 (Continued)

Factor	Variables Included
P2	Average Daily Membership as a Percent of Total Weighted Full-time Equivalent Pupils Change in Membership from First Month to Ninth Month, Grades 10-12

Note: Although other variables in the subgroup also contributed to the strength of a factor, only those variables with loadings in excess of .50 were included in this listing.

TABLE 5

RANGES OF FACTOR SCORES FOR EIGHT FACTORS

Factor	Range
S1	-3.2 to 1.4
S2	-1.1 to 4.9
S3	-2.8 to 2.4
R1	-1.8 to 2.6
R2	-2.4 to 2.7
R3	-2.0 to 3.0
P1	-2.0 to 2.4
P2	-2.0 to 3.3

Correlation coefficients for the factor scores were calculated using the procedure FACTOR of the Statistical Analysis System (SAS). Table 6 provides the resulting correlation matrix. This analysis indicated that socio-economic Factor S1, including variables measuring population density and mobility, educational level, and juvenile delinquency, was correlated at the .79 level with the programmatic Factor P1. This latter factor was primarily defined by student achievement and postsecondary education. Consequently, the use of these two factors simultaneously in funding models was controlled. The next largest correlations, R2 with S1 and R2 with P1, were not considered high enough to require control.

The factor scores for each factor were used in various combinations in regression equations to establish funding levels for each school district. That is, the factor scores of a selected set of factors were regressed against actual per pupil expenditures for 1972-73 to predict a funding level based on the need for programs measured by the factors.

Initially, stepwise multiple regression against 1972-73 per pupil expenditures was used to determine the combination of factors responsible for explaining the greatest amount of variance in the data. The SAS procedure STEPWISE was used for this purpose. Factors R1, R3, and P2 emerged with a significance level of .001 and a squared coefficient of multiple regression equal to .76. Limitations were placed on the program that permitted only the addition of those factors whose significance level was equal to, or less, than .10 and the retention of those factors in the model whose significance level remained less than, or equal to, .10 after the addition of other terms.

A free regression was then run in which all factors were regressed against 1972-73 per pupil expenditures and allowed to enter the equation according to their explanatory power. Table 7 presents the resulting

TABLE 6

CORRELATION MATRIX FOR FACTOR SCORES

	S1	S2	S3	R1	R2	R3	P1	P2
S1	1.00000	-0.00008	0.00003	0.29694	-0.45033	0.18245	-0.79983	0.19293
S2	-0.00008	1.00000	0.00003	0.08783	0.26890	0.11455	-0.03063	0.01292
S3	0.00003	0.00003	1.00000	-0.11049	-0.08195	0.00846	-0.12973	0.07695
R1	0.29694	0.08783	-0.11049	1.00000	0.00050	-0.00029	-0.09035	0.29312
R2	-0.45033	0.26890	-0.08195	0.00050	1.00000	0.00135	0.62583	0.16401
R3	0.18245	0.11455	0.00846	-0.00029	0.00135	1.00000	-0.22820	-0.14802
P1	-0.79983	-0.03063	-0.12973	-0.09035	0.62583	-0.22820	1.00000	0.00207
P2	0.19293	0.01292	0.07695	0.29312	0.16401	-0.14802	0.00207	1.00000

TABLE 7

INTERCEPT AND BETA COEFFICIENTS FOR FREE REGRESSION OF FACTORS AGAINST PER PUPIL EXPENDITURES

Factors	Value
Intercept	748.7946
S1	1.2459
S2	0.2351
S3	5.3829
R1	29.0739
R2	10.0359
R3	-44.5624
P1	-7.0430
P2	11.1518

intercept for the equation and the beta coefficients for each factor. As indicated in the table, the strongest factors, in terms of size of beta coefficients, were R3, R1, and P2. Factor R2 was the fourth strongest factor.

A program using the SAS procedure RSQUARE was used to determine whether more variance could be explained by the addition of some combination of other factors to the R1 R3 P2 model. None of the thirty-one possible combinations appeared to be significantly stronger than any of the others. Based on this information, the following eight funding models were determined for use in predicting funding levels:

Model 1	R1 R3 P2
Model 2	R1 R3 P2 P1
Model 3	R1 R3 P2 S1 S2 S3
Model 4	R1 R3 P2 S2 S3 R2 P1
Model 5	R1 P1 S1
Model 6	R1 R3 P2 S1
Model 7	Weighted S1 R1 R3 P2
Model 8	Weighted P1 R1 R3 P2

Model 1, R1 R3 P2, was adopted as a base model as a result of the stepwise regression procedure. The factors reflected primarily teacher education and experience, pupil-teacher ratio, program requirements, and pupil mobility in Grades 10-12.

In Model 2, R1 R3 P2 P1, the student achievement factor was added to obtain a model including all of the information available in the factors on the programmatic needs of pupils. Similarly, Model 3 included all of the socioeconomic factors. This combination of the socioeconomic factors was especially desirable in light of the small beta coefficients, relative to the other factors, noted in Table 7.

Model 4 included all of the factors except S1, which was excluded because of its relatively high correlation with P1. The beta coefficient of Factor P1 was sufficiently stronger than that for Factor S1 to recommend inclusion.

The fifth model, R1 P1 S1, represents the combination of the first factor scores in each subgroup of variables. However, because of the disparity in strength among the variables, this model was theoretically inefficient, although the potential for discriminating among districts appeared to be high.

In Model 6, R1 R3 P2 S1, the first socioeconomic factor was added to the base model. This model should be compared to Model 2 in which the factor correlated with S1, P1, was added to the base model.

Two additional models were generated in which the beta coefficient for one factor found in free regression was weighted in relation to the other factors included in the model. In the first instance a weighted Factor S1 was entered first into the equation, followed by R1, R3, and P2; similarly, in the second case, a weighted Factor P1 was entered first. Because of the difference between the relative magnitude of the beta coefficient of S1 and the coefficient of each of the three factors to follow it, the beta coefficient for S1 was multipled by ten and entered into the following equation:

$$P = 748.79 + 10(1.25)(S1) + 29.07(R1) - 44.56(R3) + 11.15(P2).$$

Factor P2 required only a weighting of two to produce a beta coefficient approximating the smallest of the other three factors. The weighted coefficient was entered into the following equation to form the eighth funding model:

$$P = 748.79 - 2(7.04)(P1) + 29.07(R1) - 44.56(R3) + 11.15(P2).$$

For each model specified above a regression was run to determine the predicted allocation for each district.

Phase 4: Application and Analysis. Each of the funding models was analyzed in terms of its impact on the flow of funds for financing public schools in the sample composed of school districts within the State of Florida. Two types of analysis were conducted. The first type consisted of tallies of the number of districts gaining and losing revenue in classifications of districts based on property wealth, per capita income, population density, and student achievement. In the second analysis the combined

combined characteristics of the districts gaining or losing fifty to ninety-nine dollars per pupil and one hundred or more dollars per pupil were determined for each model.

Results

The findings of this study may be divided into those relating to the analytical process and those indicating the results of the application of the formulated funding models. A reflective view of the procedures of the study indicated the following:

1. Sufficient variables for accomplishment of the study were available from standard reporting procedures of the Florida Department of Education and the U. S. Bureau of the Census.
2. Independent factors in each subgroup could be identified that accounted for between 15 and 41 percent of the variance in the data set.
3. Funding models were designed that had different effects on districts with different characteristics.
4. The changes in local district funding level per pupil predicted by the models ranged between plus and minus two hundred dollars.

In terms of specific results of the application of particular funding models, the following major effects were observed. Only increases or decreases of fifty dollars or more per pupil are considered in these statements unless otherwise noted.

1. Model 2 (R1 R3 P2 P1) and Model 4 (R1 R3 P2 S2 S3 R2 P1) tended to predict allocations in excess of actual per pupil expenditures for 1972-73 for small, rural school districts.
2. Model 1 (R1 R3 P2), Model 3 (R1 R3 P2 S1 S2 S3), Model 7 (Weighted S1 R1 R3 P2), and Model 8 (Weighted P1 R1 R3 P2)

increased the per pupil allocations for large and/or urban districts with low wealth, measured in terms of assessed valaution per pupil and per capita income.

3. In terms of property wealth per pupil, the models tended to predict increased allocations for districts having an amount equal to, or less than, $20,000 per pupil. Similarly, the models tended to decrease the allocations of districts with a property wealth equal to, or greater than, $40,001 per pupil. Models 2 (R1 R3 P2 P1), 3 (R1 R3 P2 S1 S2 S3), 4 (R1 R3 P2 S2 S3 R2 P1), and 5 (R1 P1 S1) appeared to predict more increases in allocations than decreases for districts having property wealth in the $20,001 to $40,000 per pupil range.
4. Although application of the models resulted in few increased allocations for districts whose per capita income equaled, or was greater than, $4,001, allocations for districts in this income category were not substantially decreased. Models 2 (R1 R3 P2 P1), 4 (R1 R3 P2 S2 S3 R2 P1), and 5 (R1 P1 S1) tended to predict increased allocations for districts having a per capita income of $2,000 or less.
5. Model 2 (R1 R3 P2 P1) and Model 5 (R1 P1 S1) were found to give increased allocations to districts with 2,000 pupils or fewer in average daily membership. Districts in the 2,001 to 25,000 membership range were most affected by the models, but no patterns of impact were detected. Few decreases were predicted for districts with 25,001 or more pupils in average daily membership.

6. The urban impact of the models was very limited. Models 3 (R1 R3 P2 S1 S2 S3), 6 (R1 R3 P2 S1), and 7 (Weighted S1 R1 R3 P2) tended to channel increased funds to urban areas. Only Model 3 (R1 R3 P2 S1 S2 S3) and Model 5 (R1 P1 S1) predicted a greater number of increases than decreases for districts classified as urbanized rural. Rural districts appeared to be favored by Models 2 (R1 R3 P2 P1), 4 (R1 R3 P2 S2 S3 R2 P1), and 5 (R1 P1 S1).
7. Model 2 (R1 R3 P2 P1), Model 4 (R1 R3 P2 S2 S3 R2 P1), and Model 5 (R1 P1 S1) predicted increased allocations for districts in the fourth, or lowest, achievement quartile, while Model 3 (R1 R3 P2 S1 S2 S3) was the only model that gave more increases than decreases to districts in the first quartile.
8. Models 1 (R1 R3 P2), 6 (R1 R3 P2 S1), 7 (Weighted S1 R1 R3 P2), and 8 (Weighted P1 R1 R3 P2) tended to predict a greater proportion of increases equal to, or less than, forty-nine dollars per pupil in average daily membership. Approximately one-third of the increases predicted by Models 2 (R1 Re P2 P1), 3 (R1 R3 P2 S1 S2 S3), 4 (R1 R3 P2 S2 S3 R2 P1), and 5 (R1 P1 S1) were equal to, or greater than, fifty dollars per pupil. No pattern was observed for predicted allocation decreases.

Importance

In a world in which limited resources are available for support of governmental programs and services, it becomes increasingly important to assure that available funds are used in an optimal manner, facilitating the meeting of public goals. State aid distribution methods employed for

allocating funds among school districts have traditionally considered only a very few differentiating factors. These factors usually consist of one or some combination of the following: number of students to be served, number of professionals to be supported, wealth of the school district, or predetermined cost differentials for students in certain age-groups or special programs. These measures, although they focus generally on the student to be educated, are incapable of recognizing the interaction of social, economic, and educational factors that affect the effective learning of the individual student, the operation of a school, and the administration of a school district. This study developed a systematic technique, capable of recognizing a variety of social, economic, and educational factors in individual school districts, that might permit a more definitive application of recognized state educational and political priorities to the distribution of state funds for education.